LIBRARY
STATE PLANT BOARD

June 1950 ET-284

United States Department of Agriculture
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

GRAVITY-FLOW EQUIPMENT FOR DISPERSING INSECTICIDES FROM AIRCRAFT[1/]

By Frank S. Faulkner, C. C. Deonier, and A. N. Davis,
Division of Insects Affecting Man and Animals

Because of the uneven output of spray from gravity-flow equipment previously used in airplanes, such equipment has proved less satisfactory generally than pump-operated spray equipment. A gravity-flow unit has been developed which provides a fairly constant flow of solution and appears to give about as good results as a pressure unit.

The gravity-flow unit was designed for use on PT-13 or PT-17 planes. It consists of a tank in the front cockpit and under-wing venturis to increase the breakup of the sprays. The installation is satisfactory for dispersing oil solutions or stable water emulsions, but not for suspensions, which require constant agitation to prevent settling.

Description of Equipment

An 80-gallon aluminum tank, designed to fit the front cockpit without removing the rudder pedals or altering any of the structures in the plane, rests on a 2-inch angle aluminum platform and is held in place by a clamp over the top of the tank. Baffles in the tank prevent the liquid from shifting when the plane is maneuvered and make the sides of the tank more rigid. A constant flow rate is obtained by sealing the filler neck with an airtight cap, and as the liquid is released the displacing air is drawn in through a breather tube. The breather tube extends from 1/2 inch above the bottom of the tank, through the tank, to 1/2 inch above the top of the tank. Tanks of higher capacity can be used when the front cockpit control does not have to be retained.

Two 7/8-inch (inside diameter) booms, each 110 inches long, are located under the wings 24 inches below the bottom of the tank. A 1/2-inch, quick-action cut-off valve is located 7 inches inboard from

1/ This work was conducted under funds allotted by the Department of Defense to the Bureau of Entomology and Plant Quarantine.

the tip of each boom to obtain instant control of the liquid. Interchangeable nozzles are inserted into the end of the booms to give the breakup and rate of flow desired. These nozzles are made from pipes having inside diameters of 1/4, 5/16, or 1/2 inch, the tips of the pipes being cut off at a 32° angle. The spray is released into venturis attached to the ends of the booms (fig. 1).

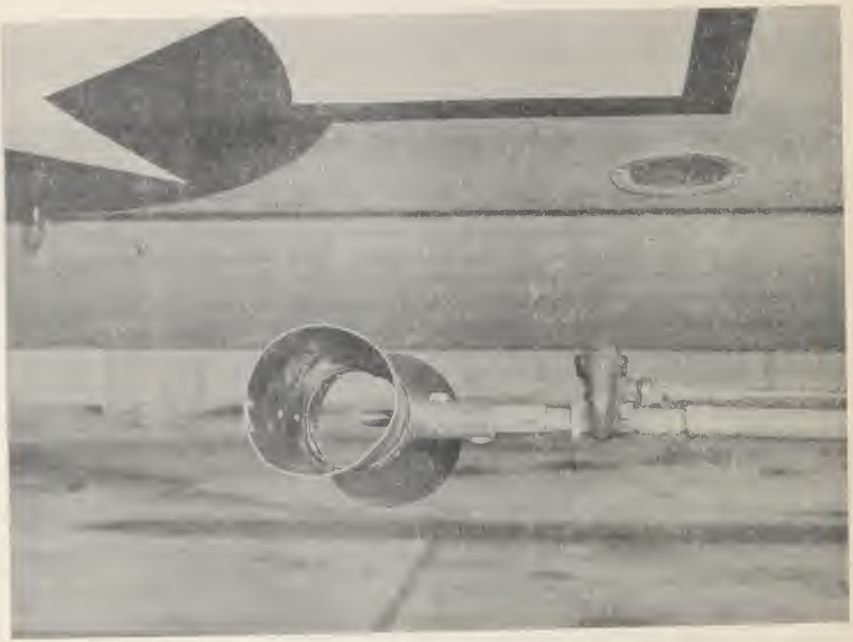


Figure 1.--Valve, venturi, and cut-off valve assembly.

The venturi has an over-all length of 13 inches, a maximum diameter of $5\frac{1}{2}$ inches, and a throat diameter of 3 inches. A sleeve made of tubing having a slightly larger inside diameter than the outside diameter of the boom is riveted to the throat of the venturi and extends out from the venturi at a right angle. This sleeve telescopes over the end of the boom and is secured to the boom by set screws. The tip of the nozzle extends 2 inches into the throat of the venturi and the 32°-angle cut faces toward the rear.

Performance Studies

Studies to determine the delivery rates for the gravity-flow equipment were made with several sizes of nozzles and breather tubes. The results of these determinations are shown in table 1. Two 1/4-inch nozzles gave a rate of flow of 2.9 gallons per minute; 5/16-inch nozzles gave 4.3 gallons; and 1/2-inch nozzles gave 7.4 gallons. Constant rates of flow were obtained with each nozzle. Little or no difference in rate was caused by varying the size of the breather tube from 3/16 to 3/8 inch. The greatest differences occurred with the 1/2-inch nozzle. Without a breather tube each nozzle gave a high initial rate of flow which declined gradually as the volume of liquid decreased.

With a single venturi under each wing, the spray was distributed unevenly, the heaviest deposit being directly under each wing tip. This pattern apparently was caused by the air-flow characteristic of the plane, which forced the spray outward to the wing tips regardless of where the venturis were placed. This action was immediate, under favorable weather conditions, when the venturi outlets were 4 1/2 to 7 1/2 feet inside the wing tips, but at 9 feet it was somewhat delayed.

A second venturi was placed under each wing in an effort to improve the performance of the equipment. The two venturis were attached to opposite ends of an inverted T-pipe that was connected into the boom just beyond the cut-off valve. They were 3 feet apart and the outside one was 4 1/2 feet from the wing tip. With 1/4-inch nozzles the flow rate was increased from 2.9 to 5.4 gallons per minute. Particle-size determinations for this equipment showed an average median diameter of 53 microns and an average mass median diameter of 158 microns.

Three flights were made upwind at a height of 20 to 25 feet to insure a heavy deposit, and thereby increase the accuracy of colorimeter determinations. The quantity of spray distributed from the dual venturi tubes was determined from deposits of tracer dye on 6- by 6-inch plates placed at intervals of 20 feet across the swath.

The results of these tests, given in table 2 and figure 2, show an average deposit of 0.03 pound per acre, or more, over a swath width of at least 100 feet. The breakup of the spray was slightly improved by the addition of a second venturi under each wing, but the spray pattern was similar to that produced by the single venturi tubes. In each case the deposits were heavier under the tip of each wing than directly beneath the plane.

Table 1.--Delivery rate of water from gravity-flow equipment provided with nozzles and breather tubes of different sizes.

Size of nozzles 1/ (inch)	Size of breather tube (inch)	Quarts delivered in indicated number of minutes												
		0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26
1/4	3/16	23.75	23.75	23.75	23.5	23.5	23.25	23.25	23.0	23.0	22.75	22.75	22.5	22.25
	1/4	23.8	23.8	23.8	23.8	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.3
	3/8	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.5	23.5	23.25	23.25	23.25	23.25
	None	34.25	33.0	32.0	31.0	29.75	29.0	28.0	27.0	26.0	24.75			
5/16	3/16	33.0	33.0	33.0	33.0	32.75	32.5	32.75	31.75	31.5				
	1/4	35.0	35.0	35.0	35.0	34.8	34.75	34.6	34.5	29.0				
	3/8	34.5	34.5	34.5	34.5	34.25	34.25	34.25	34.25	33.5				
	None	51.0	49.0	46.5	46.75	42.0	39.0	36.0						
1/2	3/16	51.5	51.5	51.5	51.0	50.5	49.0							
	1/4	55.0	55.0	55.0	54.75	54.0	39.0							
	3/8	59.5	59.5	59.0	59.0	59.0								
	None	82.5	79.0	72.0	64.0									

1/ 2 nozzles used for each.

Table 2.--Recovery of DDT at various stations at 20-foot intervals from line of flight (station 9). Sprays applied with PT-13 airplane provided with gravity-flow equipment.

Flight No.	Pounds of DDT per acre at indicated station											
	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14
2	0.004	0.003	0.282	0.044	0.081	0.058	0.040	0.140	0.060	0.011	0.004	
3	.002	.002	.010	.009	.019	.124	.019	.093	.047	.033	.017	0.001
4	--	--	--	.002	.033	.091	.075	.054	.065	.056	.008	.003
Av.	.003	.003	.019	.018	.045	.091	.045	.096	.058	.034	.010	.002

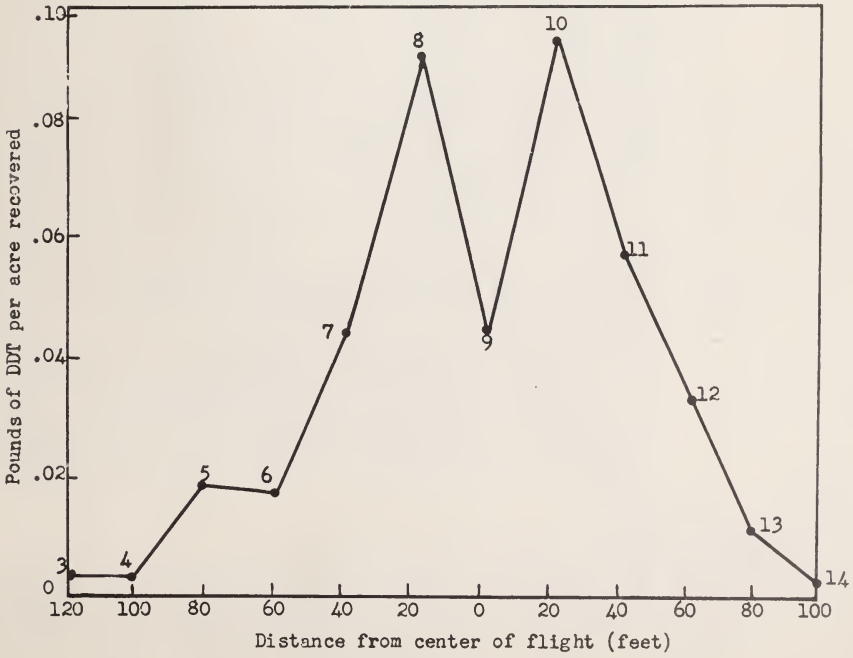


Figure 2.--Graphical representation of average data given in table 2.

UNIVERSITY OF FLORIDA
3 1262 09242 9140

Effect of Air Currents on Sprays

Observations were made on the effects of air current on sprays released at different points under the wings and under different weather conditions. The release of a quantity of material at a single point emphasized the effects of erratic air currents which are not so apparent when the conventional multiple-nozzle boom is used.

From photographs taken in the afternoon to show the roll given the spray by the wing tips, it was found that the spray pattern changed completely as the afternoon temperatures and wind speeds increased, and that under such conditions the wing-tip air currents did not appreciably affect the spray released 6 feet inside the wing tips. In cross-wind flights light breezes prevented the spray from fanning out in a characteristic roll and the result was a heavier deposit under the up-wind wing.

Samples of the dispersed sprays were obtained on slides coated with magnesium oxide. Each slide was exposed to the spray immediately after it was released from the plane and before the large and small droplets became segregated. Under some conditions more large drops were taken on the outside of the spray-roll off the wing tip and smaller drops were present on slides exposed inside and close under the plane.

A test of sampling technique was made in which slides were placed at 3-foot intervals across a concrete air strip and at right angles to the line of flight. The spray plane was flown so low that the wheels touched the runway momentarily as the airplane passed over the line of slides. At this elevation drops were not impinged on any of the slides except those at the wing tips and beyond, even though the spray was released from venturis located 6 feet and 9 feet in from the wing tips.

The point of spray release is highly important and further studies are necessary on proper locations for nozzles to give the most uniform swath. Further studies on air currents set up by various types of aircraft are also needed.